MODIS DATA SYSTEM STUDY

TEAM PRESENTATION

October 21, 1988

AGENDA

1. Minutes of the Meeting with Sol Broder on October 17
2. Outline of the October 13 EosDIS Meeting
3. Salient Points of the October 20 Meeting on User Access
4. User Access Operations Concepts
5. Standard Grids for MODIS, HIRIS, and EosDIS
6. Quick-Look Data Scenarios for the MODIS Data System
7. Analysis of MIDACS Quick-Look Requirements
8. Action Items

MINUTES OF THE MEETING WITH SOL BRODER ON OCTOBER 17, 1988

A meeting was held with Sol Broder regarding the communications requirements of a distributed TMCF. The participants in the discussion were M. Andrews, P. Ardanuy, S. Broder, S. Jaffin, T. Johnson, D. MacMillan, and A. McKay.

One of the main topics of discussion concerned the roles of the TMCF and the IMC. One version of these roles is given by the TMCF Contract Diagram (MODIS Study Team), which indicates that the CDHF processing will be controlled by the TMCF. Alternatively, there is a concept that the CDHF will be driven by the IMC. It was pointed out that, especially if there is one CDHF for all instruments, there must be some mechanism for allocating CDHF resources among the processing requirements of different instruments.

Temp Johnson wants to model the EosDIS communication network to determine the optimum network architecture. As input he needs the following:

- locations of functions (e.g., where the TMCFs are located)
- type and data rates of transactions between functions
- scenarios for all modes of the system (e.g., standard processing, near-real-time processing, real-time processing, or browse processing).

Another question that came up was how will EosDIS access non-EOS instrument data or data from another platform. For example, Joel Susskind will require Level-2 AIRS/AMSU data to produce cloud products from MODIS data, but AMSU is a NOAA instrument. It appears that, in this case, NOAA will be responsible for processing NOAA instrument data only to Level-1A and -1B and EOS will process these data to higher levels. Clearly, the communication link for Level-1 NOAA data to EosDIS must be designed to meet MIDACS data production schedules.

Other questions raised in the discussion were:

1. What will the data links be for the network of distributed TMCFs? For instance, what kind of data links will there be to international users?

2. What will the science requirements for browse data be?

OUTLINE OF THE OCTOBER 13, 1988 EosDIS MEETING

The topics of interest to the MIDACS Team were:

1. The CDOS development effort in Code 500 includes the development of an EMOC Operations Concept. Steve Tompkins is in charge of this effort.

2. The functions of the PSCN, a network comparable to NASCOM, which will transmit data between the major nodes (NASA Centers) and tail circuits (universities) include:

   - Data
     - Switched 56 kbps
     - Dedicated 1.544 Mbps
   - Voice
   - Message
     - Video
     - Fax

(NOTE: NASCOM transmits data from spacecraft to CDOS, from CDOS to EosDIS, within EosDIS, and from EosDIS to data centers.)

3. A Science Processing Team within the EosDIS Study Team is working on the real-time and near-real-time requirements for EosDIS. The MODIS requirement was discussed briefly by Daesoo Han.

4. The DHC will store ancillary (platform) data for two years or longer if Code E provides the funding.

5. An EosDIS Planning and Scheduling Scenarios Report was submitted by Steve Tompkins at the September 29, 1988 EosDIS Meeting.

6. P. K. Bhartia discussed the formation of a Science Data Processing Support Team within Code 600. This Team will coordinate the development of the EosDIS and will remain in force during the operations phase of EOS.

7. A "Requirements Change Request" form was presented and the plan for the EosDIS Requirements Team (ERT) review process was presented by CTA. The goal is to develop Level-2 requirements for the EosDIS Phase-B Study. A "Review Item Discrepancy" form was also presented. Samples of these forms and the ERT Review Package are attached.

8. The EosDIS Phase-B contract award date will be sometime after December 15, 1988.

Earth Observing System Data and Information System
REQUIREMENTS CHANGE REQUEST

☒ NEW
☐ CHANGE

1) RCR #: 001	2) INTERNAL #:	3) DATE RECEIVED:	4) DATE SCHEDULED:
5) ORIGINATOR: Don McConathy	6) ORGANIZATION: CTA	7) PHONE #: (703) 848-2714	8) DATE SUBMITTED: October 6, 1988

9) REQUIREMENT ID: (BLANK IF NEW)

10) RELATED EosDIS REQUIREMENT IDs:

Level II Requirements 585 and 889

11) CHANGE TITLE: (≤ 100 CHARACTERS)

Ancillary Data Storage

12) PRIORITY:

☐ EMERGENCY
☐ URGENT
☒ ROUTINE

13) CHANGE SCOPE:

☒ INTERNAL
☐ EXTERNAL

14) TITLE OF DOCUMENT TO BE CHANGED:

EosDIS Requirements Level I, Revision A, dated March 15, 1988

15) OTHER AFFECTED DOCUMENT(S):

EosDIS Requirements Level II

16) IMPACTED ORGANIZATION(S):

CDOS (DHC), and POIC (ESC)

17) DESCRIPTION OF CHANGE: MARK UPS INCLUDED? ☐ YES ☒ NO

The EosDIS shall provide storage for ancillary data for the duration of the mission.

Continue on Separate Sheet

EosDIS REQUIREMENTS CHANGE REQUEST (Continued)	RCR#: 001

18) RATIONALE:

To provide for the long-term storage of ancillary data. To maintain consistency between the EosDIS Level I requirements and the EosDIS Level II requirements.

19) IMPACT OF NON-CHANGE:

The Level II requirements on ancillary data storage will not have a parent statement residing within the Level I requirements.

20) TECHNOLOGY IMPACT:

N/A

21) RISK:

N/A

22) DECISION:

- ☐ APPROVED
- ☐ DISAPPROVED
- ☐ PENDING
- ☐ CLARIFICATION REQUIRED

ACTION ITEM # ______

23) COORDINATION:

CODE	INITIALS	CODE	INITIALS

24) RRB CHAIRMAN's SIGNATURE:

______________________ DATE ______

SCHEDULE TO IMPLEMENT THE FIRST ERT REVIEW

Complete First Draft of Requirements (separate CTA and JPL)	9/30
Meet to discuss ERT agenda and document preparation (JPL and CTA)	10/6
Distribute First ERT Package	10/18

a. Introductory Letter from Strat
b. Review procedures and change form
c. Agenda for ERT Review
d. List of material used as input to process
e. Level II Requirements Document Outline
f. Draft Level II Requirements (two versions of CTA requirements (annotated with source statements and requirements only) and JPL Requirements

Meet to produce consolidated set of requirements (JPL and CTA)	10/31-11/4
Distribute consolidated requirements listing	11/8
Conduct ERT Review	11/15-11/17

PROCEDURES FOR THE EosDIS REQUIREMENTS TEAM (ERT) REVIEW

1. Requirements will be reviewed sequentially using the proposed Level II Requirements document produced subsequent to the combined internal review performed by JPL and CTA on 31 October - 4 November.

2. Any previously submitted RIDs will be addressed at the time the requirement in question is being reviewed.

3. Only the discussion that is recognized by the MOM or his designee will be acknowledged as valid input to the review; sideline discussion is strongly discouraged, and will definitely not be included as input.

4. Discussion on any given requirement will be limited to 5 minutes. After that time period, an action item will be assigned to resolve the issue generating the discussion.

5. Blank RID forms will be supplied during the review; these will be used for proposed revisions to existing requirements as well as for the generation of new requirements. Only one RID for a given requirement will exist at the end of the review, unless there is an action item to resolve discrepancies.

6. Any change requests against a Level I requirement will be collected and forwarded to the EosDIS Requirements Review Board (RRB) for evaluation.

AGENDA FOR FIRST ERT LEVEL II REQUIREMENTS REVIEW

<u>DAY 1</u>

Overall System
Mission Planning and Scheduling
Mission Operations Coordination
Command and Control
Data Acquisition
Data Processing
Data Storage
Data Distribution

<u>DAY 2</u>

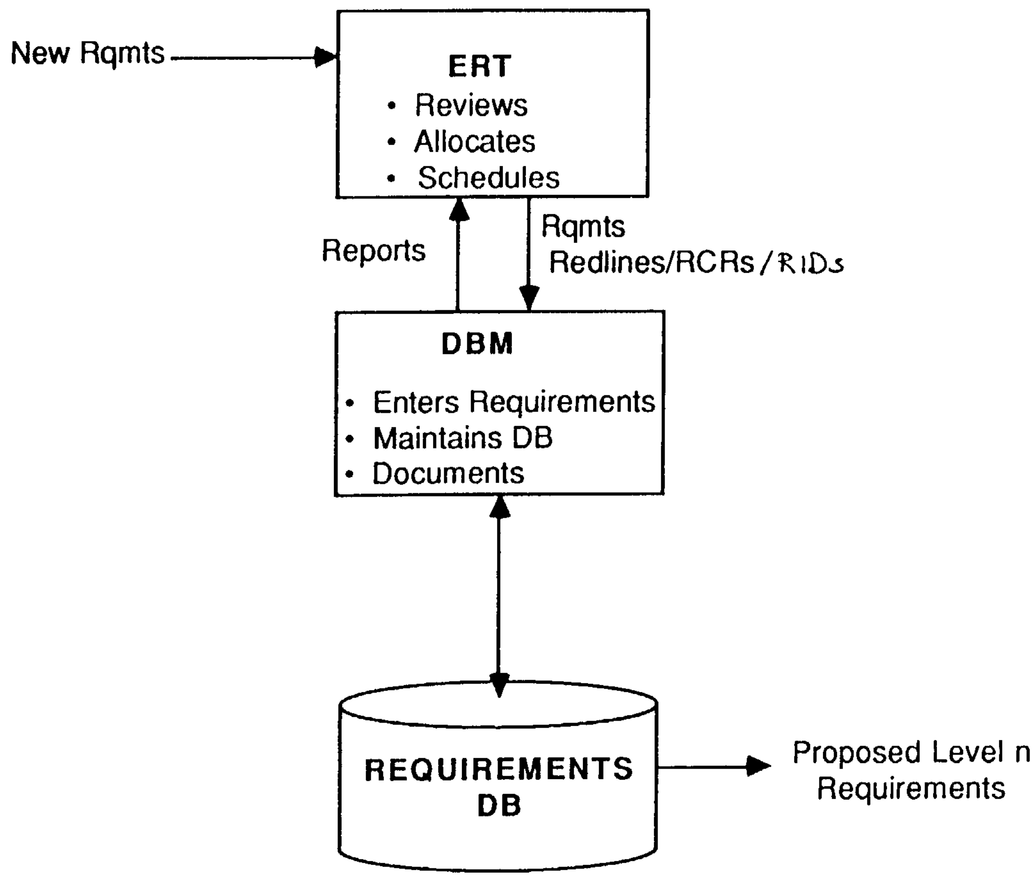
Information Management
End-to-End Fault Management
Flight Segment

Eos
Space Station Information System
- WP-3
- CDOS
- POIC

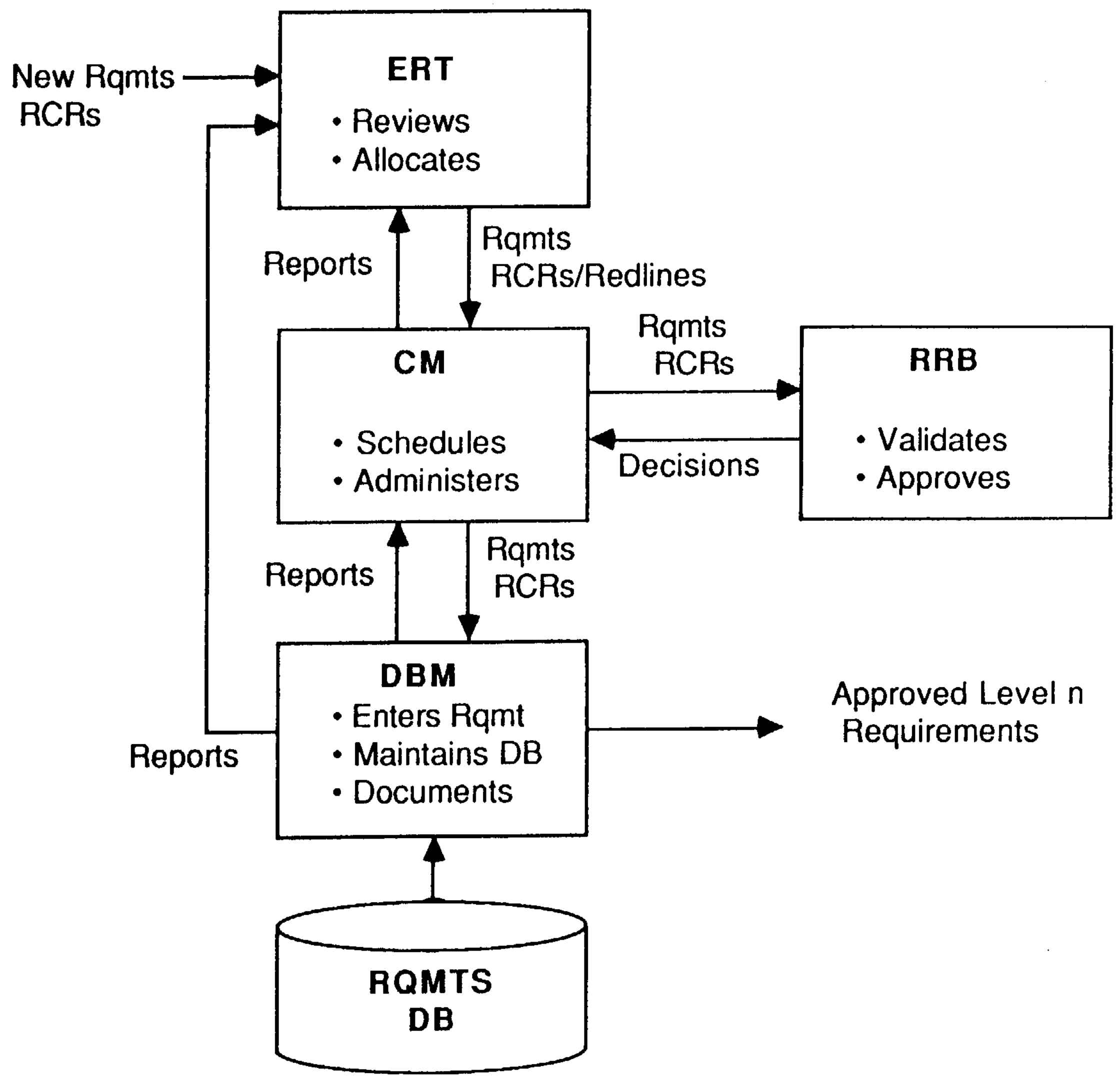
<u>DAY 3</u>

NOAA
NASA Institutional Elements
- Networks
  - Space Network
  - NASCOM
  - PSCN
  - Other Networks
- Data Systems and Archives
- Flight Dynamics Facility

Cooperating Institutions
Users
International Partners



Overview of Review During Requirements
Definition Process



Overview of Review During EosDIS
Configuration Control Process

Earth Observing System Data and Information System
REVIEW ITEM DESCREPANCY

1) REQUIREMENT ID:	2) RID #:

3) TITLE OF CHANGE:

4) RECOMMENDATION:

- ☐ NEW REQUIREMENT (Text in Block 5)
- ☐ REWRITE REQUIREMENT (Text in Block 5)
- ☐ DELETE REQUIREMENT
- ☐ MOVE REQUIREMENT WITHIN DOCUMENT FROM SECTION ________ TO SECTION ________
- ☐ OTHER ____________________

5) DESCRIPTION OF CHANGE:

6) RATIONALE:

7) ORIGINATOR:	ORGANIZATION:	TELEPHONE:	DATE PREPARED:

8) DISPOSITION:

- ☐ ACCEPTED
- ☐ DENIED
- ☐ ACTION ITEM ASSIGNED TO ____________________ DUE DATE: ____________

9) COMMENTS:

Continue on Separate Sheet

SALIENT POINTS OF THE OCTOBER 20 MEETING ON USER ACCESS

1. Attendees: Vince Salomonson, Wayne Esaias, Phil Ardanuy, Stan Jaffin, Al McKay, Bruce Sharts, and Dan MacMillan

2. Much can be learned from the experience with PCDS, PLDS, and common data formats. We will contact personnel involved in these areas and also both local and remote users of the data systems (e.g., Dr. Dutton at Penn State).

3. It appears that the majority of user queries for metadata will involve queries on the availability of MODIS data for specific periods and domains. An exception to this will be in the case of MODIS-T where tilt information will also be extremely useful.

4. Where browse data is concerned, it seems like information on cloudiness will be of the greatest importance.

5. It is not felt that browse data should be a major driver of the data system.

6. For the browse data, two types are anticipated: (1) FOV data and (2) gridded data.

7. For gridded data, a 20-km equatorial resolution yields a global grid of 2,048 by 1,024 elements. This can be broken down into eight 512 by 512 scenes which would cover the world on a daily basis and would be amenible to browsing.

8. As such, we would have to extend the definition of a Level-3 product to include gridded MODIS radiance data.

9. It is anticipated that about four channels of MODIS-N and four channels of MODIS-T data would be sufficient for browse purposes. For example, in the case of MODIS-N, the channels would include a thermal near-IR shortwave and visible bands. A one byte resolution will probably be sufficient.

10. Annotation of the browse products should be standard in terms of labeling, latitude/longitude grid, and geographical boundaries.

11. It is worth considering distributing browse data on disk to users and perhaps also mailing hardcopies of browse images to users.

12. In addition to the eight regions noted above, there may be specific browse regions defined by geographical location such as the Gulf of Mexico, the Arabian Sea, the South Pole, etc.

13. In addition to the gridded browse data, it will be possible to browse higher spatial resolution by considering the FOV images, which could be partitioned by 2,000 by 2,000 km

scenes, twenty of which would comprise a full MODIS orbit. At every fourth pixel, these browse images would have five times the spatial resolution of the 20-km gridded fields.

14. It was also suggested that we gather information from the EROS Data Center, NOAA/NESDIS, and the GSFC CZCS browse/metadata facilities. As a further information source, the Graduate School of Oceanography at the University of Rhode Island is involved in a definitive study of common standards for AVHRR SST products.

USER ACCESS OPERATIONS CONCEPTS

Preface

Introduction

Definition of Users

- o Team Members
- o Other MODIS Personnel
- o U.S. Scientific Community
- o U.S. Public Domain
- o Foreign

Types of Data to be Accessed

- o Meta (include bases for selection and definitions)
- o Browse (include bases for selection and definitions)
- o DADS Levels 1-N (define products)
- o Archived Levels 1-N (geographically dispersed and some are controlled by non-NASA entities)

Purposes of Data Access

- o Pre-Release (checkout and DQA; list steps and outcomes)
- o Routine Processing to Level 4
- o Re-processing
- o Scientific Inquiry
- o Other

Access and Usage

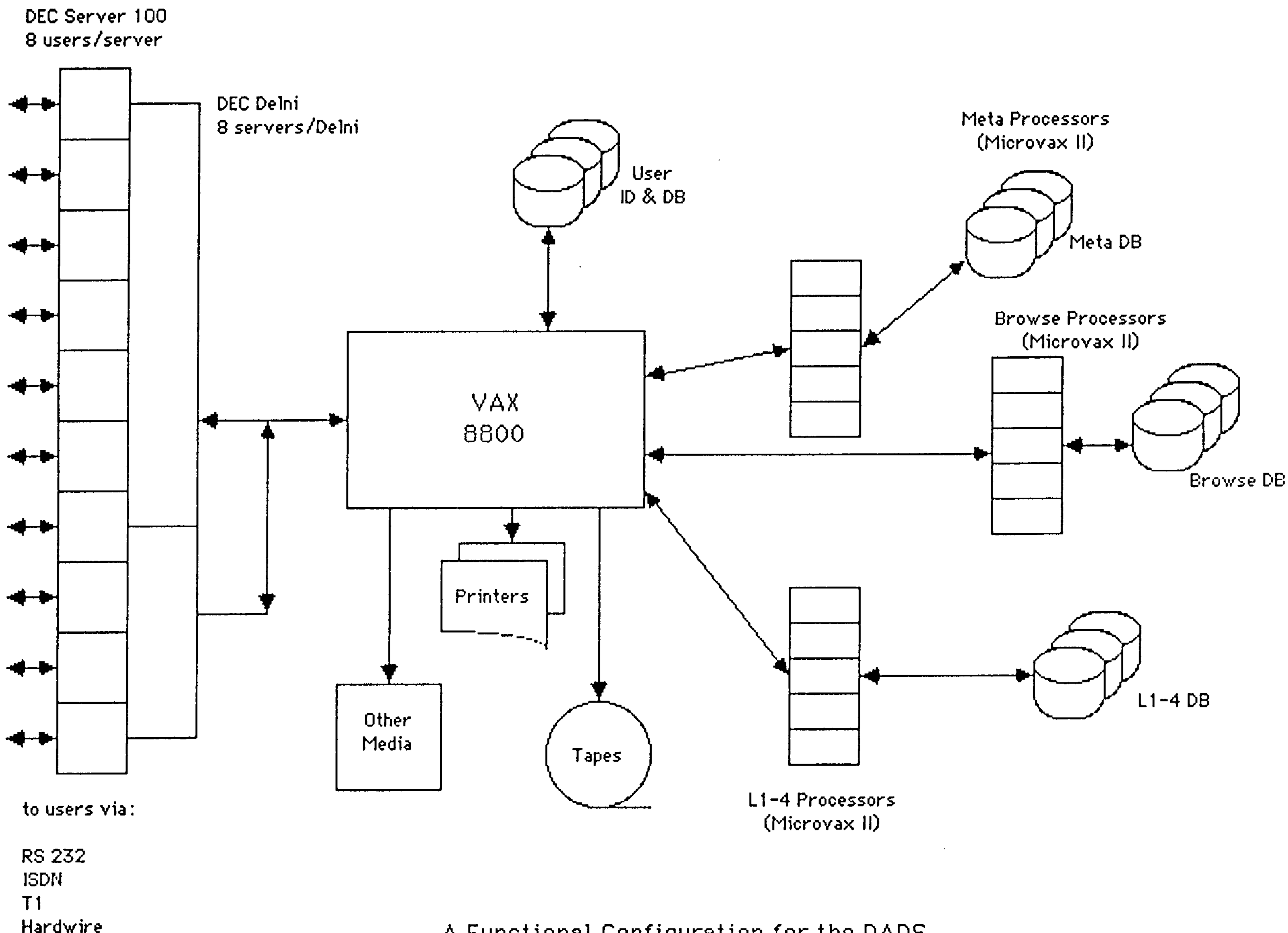
- o Obtaining an Individual or Organizational Account
- o Interactive Query and Retrieval (definition)
- o Batch Query and Retrieval (definition)
- o User Documentation and Tutorials
  - Training
  - Manuals
  - Query by Example
  - Stored Query
  - Menu-driven Query Building

- o Remote Access
  - Terminal or PC Emulation
  - Communications (ISDN, RS-232)
- o On-site Access (Physically Within Entry Point Facility)

Access Concepts

- o Single Entry Point to System (Location TBD)
- o Average Internal Duration for Initial Response
  - Query Parsing--5 seconds
  - Meta Retrieval--5 seconds
  - Browse Retrieval--10 seconds
  - L1-4 Retrieval--20 seconds
  - Archived Retrieval--TBD seconds
- o Expected Batch Responsive Time (TBD)
- o Routing of Output
  - User's Terminal (non-graphics or TBD quantities of graphics)
  - Processing site Pickup area
  - Packaged and sent to user
- o Accounting and Billing
  - Computing Resources
  - Output Production and Distribution
- o Non-Query Output
  - PR Handouts
  - Catalogs
  - Atlases
- o Security
  - System Access
  - Protection of MODIS Information
  - Protection of Configuration

- User Assistance
    - System Usage
    - Interpretation of Scientific Data



A Functional Configuration for the DADS

STANDARD GRIDS AND EOSDIS

It is important that the MODIS and HIRIS Level-3 products, as well as those from other related EOS instruments such as AIRS, be produced on common grids. The use of such common grids would greatly facilitate research applications requiring data sets from more than one EOS instrument. For some applications, such as global climate, a latitude/longitude grid system may be optimal. For other applications, such as Earth resources, equidistant grid systems have proven to be the most useful. The choice of grid type and resolution often depends on the spatial scale chosen, for example with large regional or global applications versus limited domain studies.

Latitude/Longitude Grid Systems

The types of grids to be employed could include a global 1° mesh (with 180 x 360 = 64,200 elements), a 2.5° mesh (with 72 x 144 = 10,368 elements), and a 5° mesh (with 36 x 72 = 2,592 elements). Advantages of this type of grid include a compatability to many previous data sets, including Earth radiation budget and meteorological, as well as intuitive familiarity with the Earth's geography, and direct compatability with many presently existing plotting packages. A disadvantage of this type of grid include a variable spatial resolution, with a much higher resolution near the poles.

Equidistant Grid Systems

The types of grids to be employed could include regional 1 km, 5 km, 10 km, 20 km, 50 km, and 100 km meshes, as well as a global or near-global mesh with resolutions of 100 km or better. Grid resolutions of less than 1 km would certainly be desireable for HIRIS, and as such should be coregistered to the common MODIS/HIRIS grids at lower resolutions, but would not directly apply to MODIS unless some of the MODIS-N non-baseline channels were selected.

MODIS/HIRIS Data As Scenes

By defining a "scene" as being composed of five minutes (about 2000 km) of MODIS data at full swath width, a further type of data treatment becomes possible. About 20 of these scenes would be generated during each orbit. These scenes could then be located into a common scene data base. A user would then be able to access this metadata and conveniently identify those days for which specific regions of interest were sampled. These MODIS scenes should relate directly to corresponding HIRIS scenes or subscenes at the higher HIRIS spatial resolution.

QUICK-LOOK DATA SCENARIOS FOR THE MODIS DATA SYSTEM

Quick-look data is seen as fulfilling two functions within the MODIS Information, Data, and Control System (MIDACS): (1) Real-Time Health and Safety Monitoring of the Instrument and (2) Near-Real-Time Support of Field Experiments.

I. Real-Time Health and Safety Instrument Monitoring

II. Near-Real-Time Support of Field Experiments

1. PLANNING

The MODIS Science Team member keeps the Team Leader informed as the planning for an upcoming field experiment develops. Specific information of interest includes the start date and duration of the experiment, its location, the MODIS Level-1,2, and 3 data required, and the timeliness requirements for the data. This communication occurs within the distributed TMCF.

2. DELIVERY OF SUPPORT PLAN

The planning concludes with a formal plan for the field experiment, as well as the definition of the MODIS near-real-time data sets required to support the MODIS Science Team Member's contribution to the experiment. The team member formally delivers the support plan electronically from one TMCF to the Team Leader in the TMCF at NASA/GSFC for approval. In <u>this</u> scenario, the plan is as follows:

Experiment Start Date:	December 17, 1988 (in 60 days).
Experiment Duration:	14 days
Experiment Location:	Cape Hatteras
Timeliness Requirements:	Daily; within four hours of real time.
Coverage Requirements:	A single MODIS scene (2000 km square); two scenes every third day depending on the POP-1 orbit.
Level-1B Data Required:	15 channels MODIS-T; 2 channels MODIS-N
Level-2 Data Required:	15 standard products
Level-3 Data Required:	15 products on 10 km MODIS standard grid

3. SCHEDULING AND COMMANDING

After review, the Team Leader approves the data request and forwards it via the IST to the ICC as an "observation_request." The ICC tests the plan on the simulator and then reviews the plan with the EMOC to test for conflicts. After approval of the plan by the EMOC, a "command_load" is generated and sent to the EMOC/PSC. The command load assures that the MODIS instruments will observe the experiment region and that the data will be designated for near-real-time processing by the on-board processor. The command procedure is tested by generating a near-real-time trial scene for the target region well in advance of the experiment.

4. DATA PROCESSING

The CDHF is notified by the Team Leader via a "TMCF_Processing Request" to anticipate the near-real-time data. The request provides with the exact processing requirements. The automation code in the CDHF is programmed to provide the near-real-time processing for the experiment as requested. The CDHF tests the data processing software and procedures by processing the trial scene in near-real-time and delivering it to the DADS as "Archive Data_Products." [This issue is still under discussion.]

5. DATA ARCHIVAL AND DISTRIBUTION

The DADS is notified by the Team Leader to anticipate the receipt of the near-real-time data as soon as it is generated from the CDHF, and is provided with the delivery address and communications methodology for the data. The DADS verifies the delivery procedure by receiving, storing, and then transmitting the data from the trial scene in near-real time.

6. MONITORING AND EVALUATION

Both the Team Member concerned and the Team Leader are kept appraised of the outcome of the trial scene experiment, as well kept regularly informed (daily) of the status of the near-real-time processing as the experiment occurs. Corrective action is taken if required. The Team Member and Team Leader evaluate the success of the near-real-time support shortly after the conclusion of the experiment.

ANALYSIS OF MIDACS QUICK-LOOK REQUIREMENT

1. INTRODUCTION

Purpose:

To accommodate quick-look requirements of the MODIS instrument team.

To analyze MIDACS architecture to meet these requirements.

To provide candidate scenarios to satisfy these requirements.

Definitions:

Quick-look science data is direct (not delayed) MODIS instrument data downlinked during a TDRS contact.

Real-time is synonymous to quick-look for this presentation.

Priority playback is data that has been stored on tape for high rate downlink during a TDRS contact.

2. REQUIREMENTS

Monitor instrument science data in real-time to analyze instrument performance and to aid in determining the level to which the data should be processed, possibly as prerequisites to field experiment support.

Use the ICC facility to monitor instrument performance.

Provide architecture to select and monitor any four MODIS-T & -N channels for simultaneous analysis (total of 8 channels) of products to level 2.

Build and constantly refresh four scenes of data per MODIS instrument, each with dimensions of 2000x2000 km.

Use a SUN workstation to monitor and analyze data with separate workstations for MODIS-T & -N.

Receive data from the DHC in real-time during a TDRS contact and /or as priority playback.

3. ASSUMPTIONS

A SUN workstation has a 1.5 MIPS rating.

The SUN workstation has maximum ingest rate of: 0.35 Mbps for a path length (pl) of 3, 0.13 Mbps for a pl=8, 0.09 Mbps for a pl=12, 0.05 Mbps for a pl=20.

A pl of 3 is assumed for a sort, buffer and display process, 8 indicates a L0 to L1 process, 12 indicates a L1A to L1B process, and 20 indicates a L1B to L2 process.

Number of bits per scene:

Without oversampling	With oversampling (40%)
MODIS-T = 2.04e9	MODIS-T = 2.85e9
MODIS-N = 2.92e9 (day)	MODIS-N = 4.09e9 (day)
MODIS-N = 0.47e9 (night)	MODIS-N = 0.66e9 (night)

The real-time data rate for four channels is:

Without oversampling	With oversampling (40%)
MODIS-T = 0.4 Mbps, 4/64 of 6.72 Mbps	MODIS-T = .56
MODIS-N = 0.4 Mbps, 32/752 of 10.11 Mbps (day)	MODIS-N = .56
MODIS-N = 0.4 Mpbs, 4/15 of 1.69 Mbps (night)	MODIS-N = .56

A real-time scene takes 5 minutes to build.

4. RESULTS

Without oversampling
A SUN workstation with a 1.5 MIPS rating cannot monitor four MODIS channels in real-time.

Only one channel can be monitored in real-time for MODIS-T or -N using a PL of 8.

Only three channels can be monitored simultaneously in real-time for MODIS-T or -N using a PL of 3.

With oversampling (40%)
No channels can be monitored in real-time for MODIS-T or -N using a PL of 8.

Only two channels can be monitored simultaneously in real-time for MODIS-T or -N using a PL of 3.

5. CONCLUSION

The CDHF should be used to sort, buffer, and process data in real-time before transmitting instrument data to the ICC for display and scene accumulation.

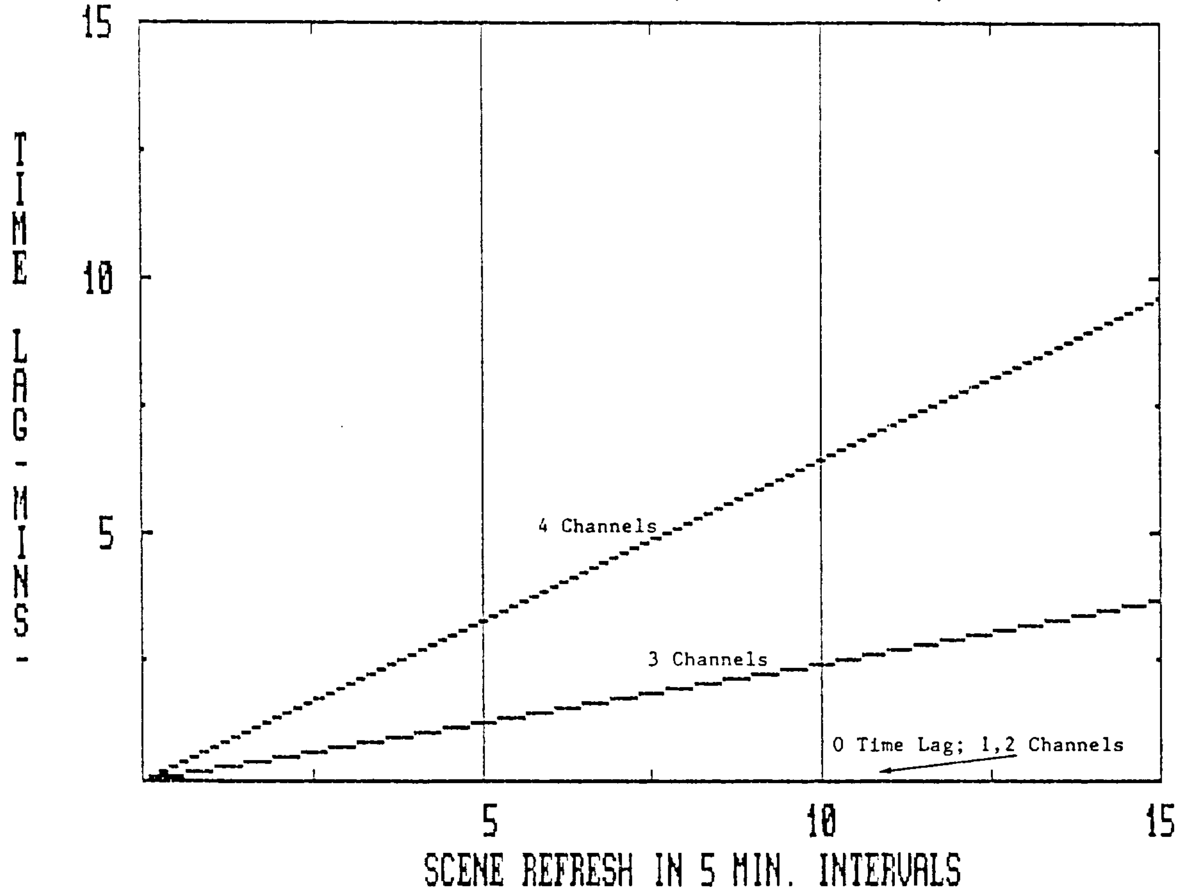
Issues/Questions

1. Can the DHC provide the MIDACS with real-time data and priority playback data 100% of the time? Can the DHC provide these data simultaneously?

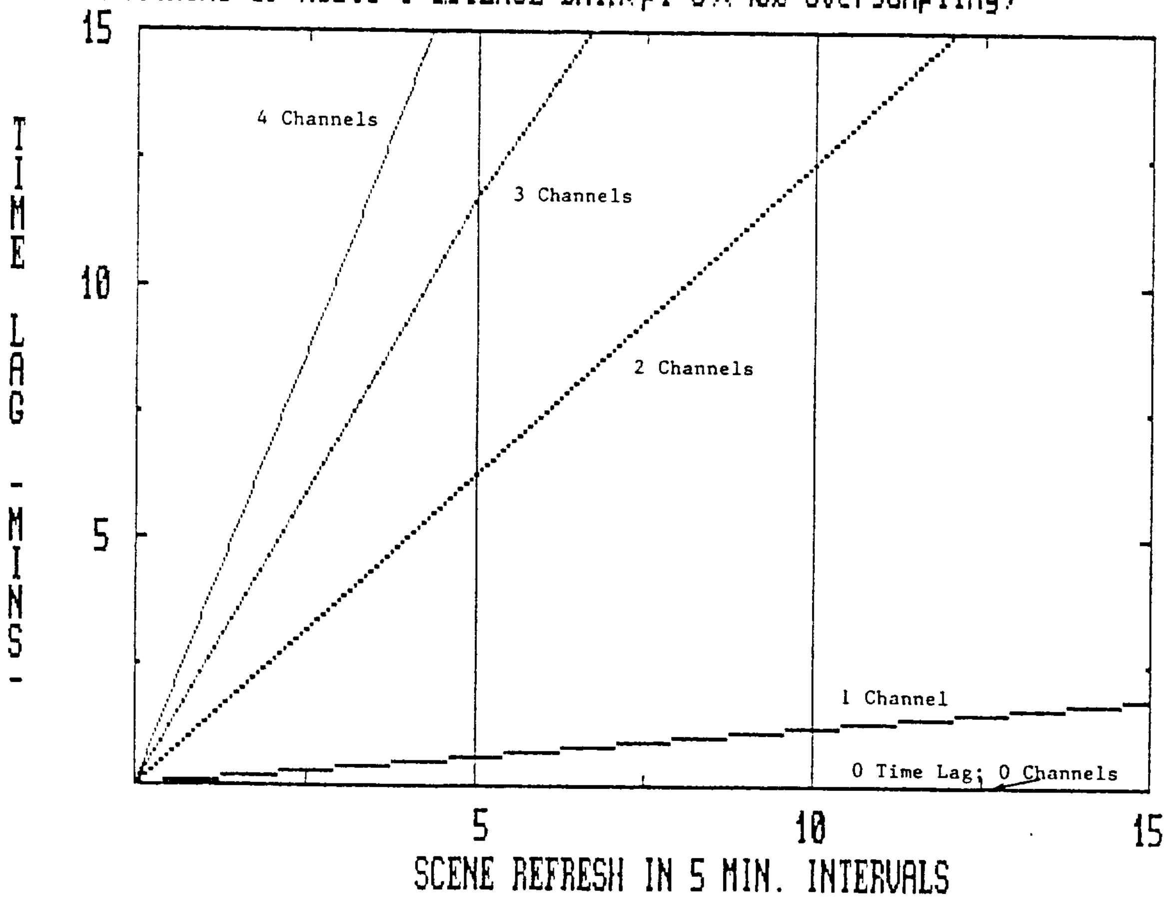
2. Will the DHC buffer priority playback data for transmission to the MIDACS?

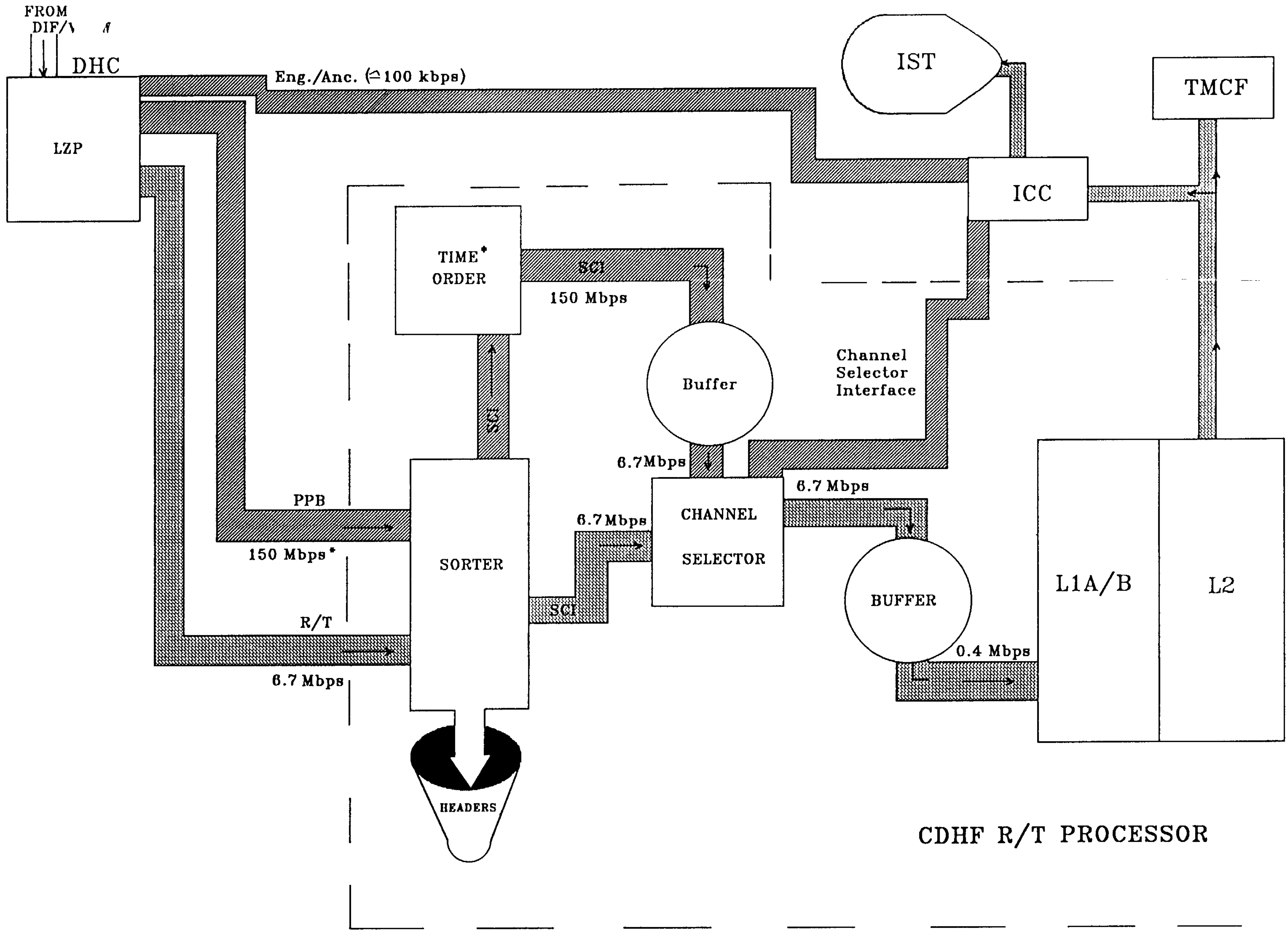
3. Should all channels be processed and stored to allow browsing capabilities?

R/T MONITORING OF MODIS-T SCIENCE DATA(p1=3)(40%oversample)



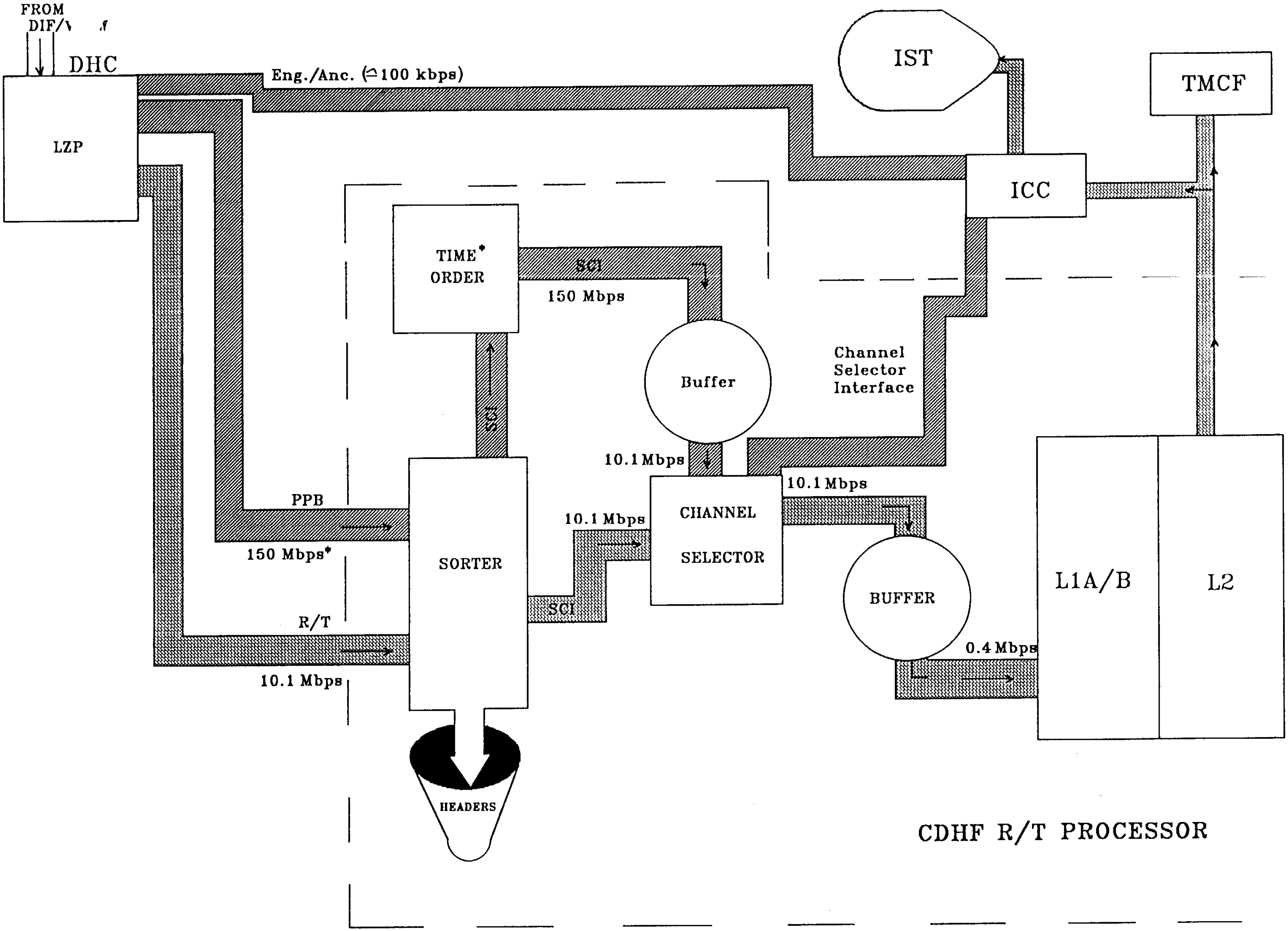
R/T MONITORING OF MODIS-T SCIENCE DATA(p1=8)(40% oversampling)





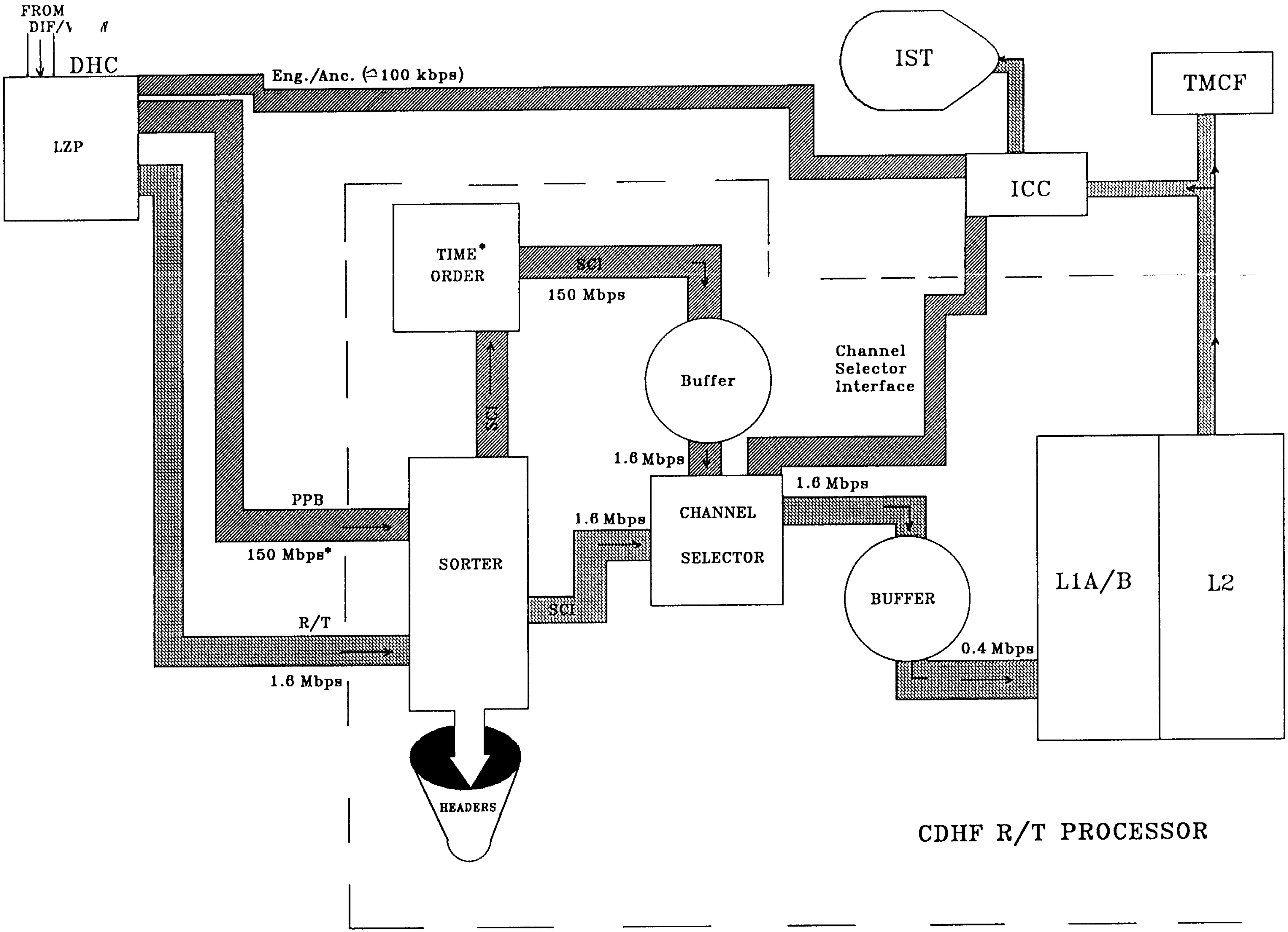
* Under Discussion

MODIS–T Quick–Look Processing



* Under Discussion

MODIS–N (Day) Quick–Look Processing



* Under Discussion

MODIS–N (Night) Quick–Look Processing

4. Should priority playback scenes be identified and preselected via commands for quick-look analysis?

6. SUPPORTING COMPUTATIONS

o Computation of SUN ingest rates

  Mbps = [MIPS x 0.7]/path length

o Computation of bits per scene

  Bits/scene = (#IFOVs)(#samples)(#bits/sample)(#swaths/scene)
  = (1294)(4096)(12)(32) , MODIS-T, 64 channels
  = 2.04×10^9

  = (1294)(752)(12)(250) , MODIS-N (day), 40 channels
  = 2.92×10^9

  = (1294)(120)(12)(250) , MODIS-N (night), 15 channels
  = 0.47×10^9

o Computation of bits per scene, 4, 3, ...1 channels

MODIS-T	4/64,...1/64 of 2.04×10^9
MODIS-N (day)	32/752,...8/752 of 2.92×10^9
MODIS-N (night)	4/15,...1/15 of 0.47×10^9

o Computation of time to refresh scene

  Real-time = (bits total/scene)/Data rate

  Monitoring-time = (bits/scene) for 4-1 channels/
  SUN ingest data rate for PL3 to PL20

ACTION ITEMS:

9/30-1: (Han) Provide a list of candidates to send the MODIS Data System Questionnaires to. A list has been made.

9/30-2: (Ardanuy) Define conceptually how the science team members will get their data (assume that the TMCF is distributed and that 9.6 kbps is not a sufficiently high data rate). In process; to be included in the User Access Operations Concepts document.

9/30-3: (Folta) Under what conditions will the DADS release data? Will the data be released automatically unless there is a notification to hold the data or will the data only be released upon explicit authorization of the science team? The DADS will only release the data upon explicit authorization of the science team. ** closed **